SPECIFICATION
TITLE

METHOD AND APPARATUS FOR TRANSMITTING INFORMATION IN VARIOUS CARRIER FREQUENCIES WITH A FREQUENCY HOPPING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is directed to a method and to an apparatus for the transmission of information in various carrier frequencies with a frequency hopping method that can be implemented, for example, in a mobile station and/or a base station of a mobile radiotelephone system.

Description of the Related Art

What is referred to as the frequency hopping spread spectrum system is known as a method for the transmission of data. What is thereby to be understood by a frequency hopping spread spectrum system is a system wherein a plurality of carrier frequencies are offered for the radio transmission of data, and the carrier frequency currently employed is changed at periodic intervals. Particularly given a time-division multiplex system (TDMA), a change of the carrier frequency can ensue after every a time slot of time frame of the time-division multiplex transmission. Such a frequency hopping spread spectrum system has advantages to the effect that the energy of the entire radio transmission is distributed over all carrier frequencies. This is particularly advantageous when a generally available frequency band such as, for example, the 2.4 GHz ISM (industrial, scientific, medical) band is employed. According to the applicable regulations (FCC part 15 in the USA), an upper limit for the maximally occurring energy per carrier frequency is defined for this frequency band in order to keep interference with other subscribers as low as possible. It is prescribed for the frequency change that at least 75 different frequencies must be used within a time span of 30 seconds. Further, each frequency may be used for a maximum of 0.4 seconds in 30 seconds. All frequencies must be used equally distributed on time average.

24 time slots, respectively 12 for uplink and for downlink, are defined in a 10 ms frame in the DECT standard. The FCC part 15, however, only makes a bandwidth of less than 1 MHz available in the ISM band. In order to meet this requirement, the number ~~plurality~~ of time slots was reduced to 12 time slots in a 10 ms time frame, i.e. respectively 6 time slots for uplink and for downlink.

With 6 time slots for each direction and retaining the DECT time frame of 10 ms, each time slot would exhibit a length of 833 µs. The time~~s~~ slots in the DECT standard have a length of 417 µs. Given a slow frequency hopping system, an inactive DECT time slot of 417 µs is required between two neighboring, active time slots wherein data are transmitted. In such systems, thus, only respectively 6 active time slots are employed for data transmission in each direction. If such systems that work on the basis of a slow frequency hopping are also to meet the requirements of the FCC part 15 in the ISM band, an inactive blind time slot of 417 µs must in turn be present between neighboring active time slots. This blind time slot thus has half the length of a full time slot of 833 µs, as a result whereof -- when a base time frame of 10 ms is retained -- four active time slots are offered in each frame for the respective uplink and downlink, a blind time slot being respectively transmitted between them. The four active time slots have a respective length of 833 µs, whereas the blind time slots comprises a respective length of 417 µs. Given this structure, the frequency programming for the frequency hopping in the next, following active time slot can continue to be implemented at the end of the preceding active time slot. The programmed start frequency in the next active time slot can thereby be set during the blind time slots.

An ~~To be cited as an~~ advantage of the frequency hopping spread spectrum system is that the system becomes more insensitive to disturbances due to the offering of a great plurality of carrier frequencies. Over and above this, the security against tapping by third parties is enhanced in the system, since the third party generally does not know the carrier frequency to which a switch is made after a certain time span.

The sequence of carrier frequencies that are successively employed for the transmission is determined by an algorithm. Such an algorithm is identically implemented in the fixed station as well as in each mobile station of the mobile radiotelephone transmission. When, thus, a mobile part is synchronized with the appertaining fixed station, the mobile part and the fixed station undertakes the carrier frequency change predetermined by the sequence of the algorithm synchronously with one another.

Problems occur when the number ~~plurality~~ of usable carrier frequencies is not temporally constant. This, for example, is the case when a carrier frequency which is recognized as disturbed is blocked during a certain time span and, thus, is not enabled for employment and, for example, is enabled for reemployment after a certain time span. Even given such a number ~~plurality~~ of carrier frequencies fluctuating over time, it must be assured that, for example, the aforementioned FCC part 15 rules are adhered to.

European Patent Document EP-A-0 182 762 discloses a method in a telecommunication system with two transmission/reception stations that selects carrier frequencies according to the frequency hopping method, whereby new carrier frequencies from a matrix with available frequencies are selected by a generation of a sequence of random numbers that reference the position of a respective carrier frequency in the matrix and on the basis of status information for the respective frequency likewise stored in the matrix, so that they are read out in ~~[...]~~ a next step.

GB-A-2 228 163 [...] a transmission system that is operated according to the frequency hopping method, with a plurality of networks comprising a plurality of transmission/reception devices, whereby the frequency stock is resolved into a plurality of sub-sets, so that neighboring time slots of neighboring networks are services with frequencies from different sub-sets for avoiding interference.

U.S. Patent No. 5,471,503 discloses ~~US-A-5,471,503 [...]~~ a method for sampling a reception signal in a telecommunication system working according to the frequency hopping method, whereby each channel is checked for an existing transmission.

SUMMARY OF THE INVENTION

The object of the present invention is to provide ~~create~~ a method and an apparatus for the transmission of information in various carrier frequencies with a frequency hopping method wherein a simple and effective offering of the carrier frequencies is assured.

This object is achieved by a method and an apparatus for the transmission of information in various carrier frequencies with a frequency hopping method ~~according to the independent claims~~. Advantageous developments of the present invention are recited in the respective subclaims.

According to the present invention, a table having a plurality of M possible carrier frequency values fx is offered in addresses 1 through N of the table, whereby the N possible carrier frequency values are arranged in N sub-groups. Further, a sequence of random values is generated on whose basis the carrier frequency values within each sub-group are read from the corresponding addresses. The sub-groups are thereby read out in a specific sequence. A part M of the N carrier frequency fx ~~x [sic]~~ is thus read out from the table, whereby $M \leq N$ applies. Subsequently, information or, respectively, data are transmitted in the corresponding carrier frequencies. The inventive method and the inventive apparatus can thereby be implemented, for example, in a mobile station and/or base station of a mobile radiotelephone system.

The generated sequence of random values is converted into address values corresponding to the respective sub-group with which the carrier frequency values are read from the respective sub-groups of the table.

Advantageously, one carrier frequency is sampled first for setting up a connection, for example between mobile radio telephone units such as a mobile station and a base station. Then a decision is made as to whether a specific message was received on this carrier frequency during a specific time span. When the decision is negative, a new carrier frequency is selected and this new carrier frequency is sampled. When the decision is positive, the sequence of random values is generated upon employment of the received, specific message. This is advantageous particularly in a mobile station of a mobile radio telephone system to which a specific message is communicated from a base station, this making it possible for the mobile station to begin the sequence of random values for reading out the carrier frequency values at the address at which the mobile station is likewise located at the moment. Since the same sequence of random values is generated in the mobile station and the base station, the same sequence of carrier frequency values is thus subsequently read out from the table. The same method is employed for synchronizing, for example, mobile radio telephone units since, for example, a mobile station likewise thereby requires a message from the base station on whose basis it can continue to read carrier frequency values from the table at the same location of the random sequence.

Advantageously, only one part j of k possible carrier frequency values is read out from each sub-group of the table, whereby the remaining k-j carrier frequency values in the respective sub-group are employed for replacing disturbed carrier frequency values of the j carrier frequency values, whereby k x n = J and j x n = M apply.

Before the readout on the basis of the random sequence, the carrier frequency values that correspond to disturbed carrier frequency values can be updated from the k-j carrier frequency values in each sub-group of the table. As a result thereof, it is assured that, even given a number ~~plurality~~ of usable carrier frequencies that fluctuates over time, the aforementioned FCC part 15 rules can be adhered to. For example, N is equal to 96 and M is equal to 78 for the case of FCC part 15. n=6 sub-

groups can then be provided, whereby k = 16 and j = 13 apply. In the case of a mobile station, this, for example, can receive a message regarding which carrier frequencies are disturbed from a base station in which the disturbed carrier frequencies were acquired. On the basis of this message, the disturbed carrier frequency values are replaced or, respectively, updated by non-disturbed carrier frequency values. The table is also updated in the same way in the corresponding base station. It should be reemphasized that the base station and the mobile station respectively exhibit the identical table and the identical algorithm for generating the sequence of random numbers. Alternatively, disturbed carrier frequency values can also be acquired in the mobile station, which then sends a corresponding message to the base station.

The aforementioned method steps are implemented in corresponding devices in the inventive apparatus. The inventive apparatus for the transmission of information in various carrier frequencies with a frequency hopping method can thereby be implemented, for example, in a mobile station or in a base station of a mobile radio telephone system.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now explained in greater detail on the basis of an exemplary embodiment and with reference to the accompanying drawings. ~~Shown are:~~

Fig. 1 is a schematic diagram of a mobile radio telephone transmission system with an inventive fixed station;

Fig. 2 is a top perspective view of a time frame of a data transmission standard as employable given the present invention;

Fig. 3 is a functional block diagram showing details of the internal structure of an inventive base station;

Fig. 4 is a schematic illustration of a frequency hopping spread spectrum system, particularly for the case of a jammer-evasion mode as well; and

Fig. 5 shows a table that is subdivided into sub-groups, whereby carrier frequency values within each sub-group are randomly read out;

Fig. 6 shows a flow chart that shows a method for setting up a connection between or, respectively, for the synchronization of, for example, two mobile radial telephone units;

Fig. 7 shows a table from which a respective part of the possible carrier frequency values is read out within each sub-group;

Fig. 8 shows a flow chart that illustrates a method for setting up a connection between or, respectively, for the synchronization of, for example, two mobile radio telephone units, whereby disturbed carrier frequency values can be replaced by non-disturbed carrier frequency values;

Fig. 9 shows a table, whereby only a respective part of the possible carrier frequency values are randomly read out within each sub-group, whereby the remaining part of the carrier frequency values not read out within each sub-group is employed for replacing disturbed carrier frequencies;

Fig. 10 shows a table, whereby a disturbed carrier frequency value from the part read out within a sub-group is replaced by a non-disturbed carrier frequency value; and

Fig. 11 shows a table, whereby another disturbed carrier frequency value in the part read out from the sub-group is replaced by a non-disturbed carrier frequency value.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to Figure 1, the general structure of a mobile radio telephone transmission shall be explained first. As generally standard, the arrangement for radio transmission of data comprises a fixed station 1 and a plurality of mobile parts (mobile stations), cordless telephones 2, 3... . The fixed station 1 is connected to the fixed network with a terminal line 10. An interface means (not shown) can be provided for communication between the fixed station and the terminal line 10. The fixed station 1 comprises an antenna 6 with which, for example, a communication with the mobile part 2 occurs via a first radio transmission path 1 or with the mobile part 3 via a second radio transmission path 9. The mobile parts 2, 3...comprise a respective antenna 7 for the reception or, respectively, the transmission of data. In Fig. 1, the condition is schematically shown wherein the fixed station 1 actively communicates with the mobile part 2 and thus exchanges data therewith. The mobile part 3, in contrast, is in what is referred to as the idle locked mode wherein, standby-like, it waits for a call from

the fixed station 1. In this condition, the mobile part 3 does not communicate with the fixed station 1 in the actual sense but receives the data of, for example, a time slot from the fixed station 1 at periodic intervals in order to be able to resynchronize its carrier frequencies fx.

The internal structure of the fixed station 1 is schematically shown in Fig. 1. The voice information data are supplied to a RF module 4 that is driven by a carrier frequency sequence unit. The exact structure of an inventive fixed station 1 shall be described later.

With reference to Fig. 2, a transmission standard shall now be explained of a type that can be employed given the present invention. As can be seen from Fig. 2, data are transmitted on a plurality of carrier frequency fx - 10 thereof being shown - in chronological succession in a plurality of time slots, 24 time slots Zx in the illustrated case, being transmitted in a time-division multiplex method in TDMA (time division multiple access). In the illustrated case, work is thereby carried out in duplex mode, i.e. following the transmission of the first 12 time slots Zx, a switch is made to reception and the twelve time slots (Z13 through Z24) are received from the fixed station in the opposite direction.

When what is referred to as the DECT standard is employed for the transmission, the time duration of a time frame amounts to 10 ms and 24 time slots Zx are provided, namely 12 time slots for the transmission from the fixed station to mobile parts and another 12 time slots Zx for the transmission from the mobile parts to the fixed station. According to the DECT standard, ten carrier frequencies fx are provided between 1.88 GHz and 1.90 GHz.

Of course, other frame structures are also suitable for employment in the present invention, for example those wherein the number of time slots per frame is cut in half compared to the DECT standard.

The present invention is particularly employed for transmissions in what is referred to as the 2.4 GHz-ISM (Industrial, Scientific, Medical) frequency band. The generally accessible ISM frequency band comprises a bandwidth of 83.5

MHz. According to the rule FCC part 15, at least 75 carrier frequencies must be distributed over these 83.5 MHz. A division of the bandwidth of 83.5 MHz onto 96 carrier frequencies is especially advantageous, i.e. a channel spacing of 864 kHz. The aforementioned frequency bands and standards are cited merely as examples.

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A fundamental precondition for ~~an~~ applicability in the present invention is merely that what is referred to is a frequency hopping spread spectrum is employed, i.e. that a plurality of carrier frequencies are available and that the carrier frequency selected for the transmission is changed from time to time. A precondition for such a change is that the data are transmitted in time slots Zx (time-division multiplex method). Thus, for example, the DECT standard is suitable, as is any other modified standard based on this DECT standard.

With reference to Fig. 3, the internal structure of an inventive fixed station 1 shall now be explained in greater detail. As can be seen in Fig. 3, information data are supplied to the RF module 4 when transmission is to be carried out from the fixed station 1 to a mobile part 2, 3...with the antenna 6, and the HF module 4 outputs information data when data when data are received from mobile parts. The RF module 4 modulates the digitally encoded information data onto a carrier frequency fx. The carrier frequency fx to be currently employed is thereby prescribed by a carrier frequency sequence unit, which is referenced 20 overall. An acquisition means 24 to which the demodulated signal is supplied from the RF module 4 is provided in the carrier frequency sequence unit 20. Disturbance thereby means that either a disturbance in the actual sense or an occupancy by some other transmitter is present. A disturbance in the sense the present specification can thus be acquired in that a received signal is demodulated on a carrier frequency and acquired as to whether a signal level is present on this carrier frequency or not. A disturbed carrier frequency is thus a carrier frequency onto which a signal is modulated that exceeds a specific threshold.

Alternatively to the blocking, the A-CRC value, the X-CRC value, a loss of synchronization or the RSSI value can be utilized.

On the basis of the demodulated signal from the RF module 4, for example, the acquisition means 24 thus determines how high the signal part modulated onto a specific carrier frequency fx is. When the acquired signal part lies above a predetermined limit value, the acquisition means 24 outputs a disturbance acquired signal to an inhibit/enable unit 21. Dependent on the disturbance acquisition signal from the acquisition means 24, the inhibit/enable unit 21 forwards an inhibit/enable information to a processor 23. This inhibit/enable information indicates which of the carrier frequencies fx are inhibited or, respectively, re-enabled due to the acquisition of a disturbance by the acquisition means 24, as shall be explained in later.

The acquisition means 24 and the inhibit/enable means 21 thus creates an independent procedure with which disturbed frequencies can be inhibited and re-enabled. In addition to being supplied with the inhibit/enable information from the inhibit/enable unit 21, the processor 23 is supplied with a sequence from a random generator 22. On the basis of ~~a [...] in~~ the implied random algorithm, the random generator 22 generates a randomly distributed sequence of carrier frequency values within the useable frequency band. The random generator 22 thus implements a procedure independent of the procedure of frequency blocking for the case of a disturbance. The processor 23, finally, outputs a drive signal to the RF module 4 that prescribes the carrier frequency value to be employed for the RF module 4.

The processor 23 comprises a table 25 provided in a memory whose function and administration shall be explained later.

With reference to Fig. 4, the operation of a fixed station 1 or, respectively, the method shall be explained in greater detail. As shown in Fig. 4, for example, a carrier frequency f1 is employed during a frame Rx of a mobile radio transmission, as shown shaded in Fig. 4. This frequency f1 is thus the first value of the sequence generated by the random generator 22 that is supplied to the processor 23, which in turn correspondingly drives the RF module 4. Let it be assumed for

the frame R2 that the random generator 22 prescribes a frequency hop P1 onto a carrier frequency f3 on the basis of its calculated frequency.

Let the case now be assumed that the acquisition means 24, for example in a prior transmission, has acquired that the carrier frequency f2 is disturbed, and the acquisition means 24 has thus forwarded a corresponding disturbance signal to the inhibit/enable unit 21 that in turn indicates an inhibit of the frequency f2 to the processor 23. Let it also be assumed that the random generator 22 prescribes the carrier frequency f2 previously acquired as disturbed on the basis of its identified sequence for the frame R3. Proceeding from the coincidence of the prescribed carrier frequency f2 according to the sequence of the random generator 22 and, simultaneously, the inhibit signal from the inhibit/enable unit 21 for the same carrier frequency f2, the processor 23 now replaces the carrier frequency f2 that was actually prescribed but was acquired as disturbed for the frame R3 by a carrier frequency that was not acquired as disturbed by the acquisition means 24, for example the carrier frequency f4, as indicated by the frequency hop arrow P3. Instead of the carrier frequency 2 actually prescribed by the sequence, thus, the RF module 4 is driven onto the alternate carrier frequency f4. By replacing the carrier frequency acquired as disturbed, thus, a modified sequence of carrier frequencies is created. The modified sequence thereby comprises only undisturbed carrier frequencies. As a result thereof that a carrier frequency acquired as disturbed is replaced and not skipped, the positions of the undisturbed carrier frequencies in the modified sequence upon transition to the following carrier frequency is not modified compared to the original sequence.

The basis of this modified sequence composed of only undisturbed carrier frequenc~~y~~ies fx is thus formed by two superimposed, mutually independent procedures (random generator 22 or, respectively, inhibit/enable unit 21). This inhibit can be in turn canceled by the inhibit/enable unit 21 as soon as a renewed acquisition by the acquisition means 24 indicates that the previously disturbed carrier frequency is now no longer disturbed. In this case, the inhibit/enable unit

21 provides an enable signal to the processors 23 that indicates that the processor 23 now no longer need replace the previously disturbed carrier frequency by a different carrier frequency.

Alternatively, the inhibit/enable unit 21 can automatically output an enable signal to the processor 23 without renewed acquisition by the acquisition means 24 as soon as a predetermined time duration has expired. Each of said procedures thus independently assures that the entire, predetermined frequency spectrum is utilized uniformly distributed. Standards are thus adhered to by the adaptation of the times in the procedure for inhibiting frequencies.

Let the U.S. rule FCC part 15 be cited as an example of such a standard. This rule prescribes that at least 75 different frequencies must be used given a frequency hopping spread spectrum system within a time span of thirty seconds. Each frequency is thereby allowed to be used for a maximum of 0.4 seconds in 30 seconds. Over and above this, all frequencies must be used equally distributed on average.

The fixed station 1 is the master in the frequency allocation, i.e. the random generator in a mobile part is initialized at the beginning of a connection setup with the status of the random number generator 22 of the fixed station 1. Subsequently, the random number generators in a mobile part 2, 3... and in the fixed station 1 generate the same carrier frequency values synchronously in the frame clock and autonomously from one another.

The mobile part comprises essentially the same structure as the fixed station 1. Like the fixed station 1, the mobile part likewise comprises a carrier frequency sequence unit 20 with a random number generator 22 and a processor 23 that contains a table 25. The table 25 is identical to the table 25 of the fixed station 1. The mobile station, however, does not comprise the acquisition means 24 and the inhibit/enable means 21. Disturbed carrier frequencies are thus only acquired in the fixed station or, respectively, base station and communicated to the corresponding mobile stations. An acquisition of disturbed carrier frequencies can

also occur in the mobile stations, whereby the mobile stations comprise the structure shown in Fig. 3 in this case. The method for transmitting information or, respectively, data in the corresponding carrier frequencies in the mobile stations corresponds to the corresponding method in the base station.

The procedure for frequency blocking that is implemented by the acquisition means 24 and the inhibit/enable unit 21 employs a unidirectional protocol on the air interface during the entire connection time between the fixed station 1 and a mobile part 2, 3... . When the acquisition means 24 finds one of the ultimately possible frequencies fx of the fixed station 1 to be disturbed, then the fixed station 1 thus informs all mobile parts with which it is maintaining an active connection that this disturbed frequency - when it is generated by the frequency of the random number generator - is to be replaced by another carrier frequency acquired as being not disturbed. The frequency inhibit is in turn canceled by the inhibit /enable unit 21 when the inhibited carrier frequency is again suitable for the transmission or, respectively, when it was inhibited for longer than a previously defined time.

It can be seen in Fig. 3 that, for example, a table 25 provided in a memory is allocated to the processor 23. With reference to Fig. 3 as well as to Fig. 5 through Fig. 11, it shall now be explained how the carrier frequencies fx are inventively offered. As can be seen in Fig. 5, all carrier frequencies fx available overall are entered into a table 25, for example 96 carrier frequencies fx.

As can be seen in Fig. 5, the carrier frequency values f_1 through f_{96} are entered in corresponding addresses 1 through 96 of the table 25 in their numerical sequence. This sequence of the carrier frequency values fx, however, is only envisioned as an example. The carrier frequency values fx can, for example, be stored in the table 25 in a different sequence.

The random readout of the carrier frequencies fx from the table 25 is thereby shown in Figures 5 and 6 given the assumption that all N carrier frequencies fx that are available are employed for the transmission of data and no disturbance is

present. Figure 5 shows the table 25 stored in the processor 23. Each address 1 through 96 has a corresponding carrier frequency fx allocated to it, whereby all 96 carrier frequencies employed are different. As indicated in Figure 5, the table 25 is subdivided into n sub-groups. In the illustrated example, wherein the table contains N=96 carrier frequency values, the table 25 can thereby be subdivided into n=6 sub-groups of k=16 carrier frequency values each. Within each sub-group, the carrier frequency values are randomly read out on the basis of the random sequence generated by the random generator 22. The n sub-groups of the table 25 are thereby read out in a specific sequence, for example in the sequence first sub-group, third sub-group, fifth sub-group, sixth sub-group, fourth sub-group and, last, second sub-group. The indicated sequence has advantages in view of the frequency hops. It supplies a maximum frequency hop of 47 carrier frequency values (3 x 16-1 carrier frequency values), whereby the minimum frequency hop distance amounts to 17 carrier frequency values (16+1 carrier frequency values).

On the basis of a random number sequence generated by the random number generator 22, the carrier frequency values are thereby written into the n sub-groups of the table 25. A random sequence of carrier frequency values is thereby first written into the first sub-group until this is full, then into the second sub-group, etc. During the data transmission, the carrier frequency values fx are randomly read out within each sub-group, whereby the sub-groups are successively read out in a specific sequence, for example the aforementioned sequence. The carrier frequency values that are read out are thereby converted into corresponding carrier frequencies in the RF-module and employed for the transmission of data or, respectively, information. The specific sequence in which the sub-groups are successively read out from the table 25 can, in addition to the above-described, advantageous sequence, be any other suitable sequence. The carrier frequency values f_1 - f_{96} stored in the table 25 are permanently stored in the respective mobile radiotelephone unit, whereby each base station of a mobile radiotelephone system can comprise a fixed table 25 allocated exclusively to it. The corresponding mobile stations respectively have the same table 25 with the identically arranged carrier frequency values. The tables 25 shown in the

tables of Figures 5, 7 and 9 through 10 are thereby only examples. The carrier frequency values fx can be arranged in any desired, other sequence.

For example, a shift register or the like can be employed for generating the random sequence in the random number generator.

The flowchart shown in Figure 6 illustrates the method for the synchronization or, respectively, for the setup of a connection of ~~2~~ two mobile radiotelephone units for example of a mobile station and a base station. Each of the method steps shown in the flowchart of Fig. 6 is implemented in a corresponding means in the processor 23. The same is also true for the method steps shown in the flowchart of Figure 8.

Upon synchronization or, respectively, upon setup of a connection of two mobile radiotelephone units, a carrier frequency fx is first sampled in a corresponding means in a step 26. The sampled carrier frequency thereby corresponds to one of the carrier frequency values fx stored in the table 25. In a step 27, a determination or, respectively, decision is made in a corresponding means as to whether a specific message was received on the selected carrier frequency. The specific message can thereby, for example, be a N_t message in the A-field of the DECT standard. Other, corresponding messages can be employed in other standards. When it is found in step 27 that the specific message was not received, a check is carried out in a step 28 in a corresponding means as to whether a specific time duration t has elapsed. When the specific time duration t has not elapsed, then the sampling of the selected carrier frequency is continued in step 26. When the time duration t has elapsed, then a new carrier frequency is selected in a step 29 in a corresponding means. The new carrier frequency is correspondingly sampled in the step 26. The two steps 27 and 28 can thereby also be implemented simultaneously in a single means. The new carrier frequency is thereby advantageously selected from a different sub-group than the first sampled carrier frequency.

When the decision in step 27 is positive, i.e. when it is found that the specific, anticipated message was received on the carrier frequency, the random number sequence permanently prescribed by the random number generator 22 is generated in a corresponding means in a step 30. The specific, received message is

thereby employed to start the generation of the random number sequence in the random number generator 22 at the position at which the mobile unit from which the specific message was received is located at the moment. This is necessary in order to assure that the two, data-exchanging mobile radio telephone units are synchronized with one another and employ the random sequence of carrier frequencies for the transmission of data synchronously with one another. In step 30, thus, the random number sequence is generated beginning with the position prescribed by the specific message and is employed for the readout of carrier frequency values proceeding from the corresponding address in the table 25. The readout of carrier frequency values fx ensues in a step 31 in a corresponding means in the processor 23 of the corresponding mobile radio telephone unit. The random number values that are generated by the random number generator 22 are thereby respectively converted into 18 address values, for example into address values 1 through 16 for the first sub-group, with which the carrier frequency values fx are randomly read out from the table 25.

Figure 7 shows a table 25 wherein only a part M = 75 of the total of N = 96 carrier frequency values fx are read out from corresponding addresses. The remaining part N-M = 96-78 = 16 of the carrier frequency values in the table 25 is employed for replacing disturbed carrier frequencies. As was explained with reference to Figure 3, for example, the disturbed carrier frequencies are identified by the respective base station. The information about the disturbed carrier frequencies is communicated to the respective mobile stations from the allocated base station, whereupon the disturbed carrier frequencies are replaced by non-disturbed carrier frequencies.

As shown, for example, in Figure 7, j = 13 carrier frequency values are randomly read out within each sub-group, whereby the remaining k-j = 16-13 = 3 carrier frequency values of each sub-group are employed for replacing disturbed carrier frequencies in the j carrier frequency values. In the illustrated example, the 96 carrier frequency values of each table 25 are subdivided into 6 sub-groups of 15 carrier frequency values each. Data or, respectively, information are thus transmitted overall in M = j x n = 13 x 6 = 78 carrier frequencies, so that the minimum rule of FCC part 15 is met. The remaining 18 carrier frequency values in the last 3 addresses

of each sub-group are only employed for transmission when one of the carrier frequencies of the first 13 addresses in each sub-group are recognized as disturbed and indicated as such by the respective base station.

Of course, this replacement and updating of the disturbed carrier frequency values must ensue synchronously in the base station and in the mobile station. Further, the identification of disturbed carrier frequencies could also ensue in the respective mobile station that sends a corresponding message to allocated base stations.

For the case illustrated in Figure 7, the random number generator 22 in the mobile station and the base station respectively outputs a random number sequence of 13 address values for each sub-group that are arbitrarily read out from the respective sub-group. As in the case of the table 25 shown in Figure 5, the sub-groups are thereby read out in a specific sequence, for example in the preferred sequence explained with reference to Figure 5.

The method for synchronization and setup of a connection of a mobile station and a base station that is shown in the flowchart of Figure 8 essentially corresponds to the method shown in Figure 6 and explained with reference to this Figure. In order to avoid repetitions, respectively identical method steps are referenced with the same reference characters.

Figure 8 shows a flow chart that explains the method steps for the synchronization or, respectively, setup of a connection of a mobile station with a base station when only 78 carrier frequency values fx are read out from the table 25. The steps 26 through 30 thereby correspond to the steps shown in Figure 6 and are also implemented here in corresponding devices in the processor 23.

In the method according to Figure 9, the table 25 is updated following the step 30 in which the random sequence was generated. As was set forth above, the random sequence is individually generated for each sub-group and respectively individually updated from addresses not read out, for example the last three addresses. This means that the base station, when it detects a specific carrier frequency in a sub-group as being disturbed, replaces the corresponding carrier frequency value in its own table 25 with a non-disturbed carrier frequency value from one of the last three

addresses of the sub-group and communicates this information to the mobile station. The mobile station replaces the same carrier frequency value, so that -- since the tables 25 of the base station and the mobile station are identical -- the carrier frequency values read out from the table 25 continue to coincide exactly with those of the base station. In the DECT standard, the specific message for updating the table 25 can, for example, be the P_t or M_t message of the A-field. Since the carrier frequency values are completely read out from each sub-group before the readout is continued at the next sub-group defined by the specific sequence, the disturbed carrier frequency values of each sub-group are replaced by the non-disturbed carrier frequency values of this sub-group that were not read out.

Figures 9 through 11 show how disturbed carrier frequency values in the first 13 addresses of each sub-group of the table 25 are replaced by non-disturbed carrier frequency values from the last three addresses of the respective sub-group.. Figure 9 thereby shows a table 25 that corresponds to the table shown in Figure 7. The first 13 carrier frequency values are randomly read out from the first sub-group. When the base station finds, for example, that the carrier frequency that corresponds to the carrier frequency value f_3 is disturbed, then the carrier frequency value f_{16} of the first sub-group, which is not disturbed, is substituted for the carrier frequency value f_3, as shown in Figure 10. The non-disturbed carrier frequency value f_{16} is thus located at the address 3, and the disturbed carrier frequency value f_3 is located at the address 16. Since the first 13 addresses of each sub-group are always read out on the basis of the random sequence, it is thus assured that only non-disturbed carrier frequencies are employed for the transmission of data or, respectively, information. When it is subsequently found that the carrier frequency that corresponds to the carrier frequency value f_{13} is disturbed and that the carrier frequency value f_3 is no longer disturbed, then the carrier frequency value f_3 is first reset to its original address 3, and the carrier frequency value f_{16} is reset to its original address 16. Subsequently, the disturbed carrier frequency value f_{13} is set to the address 16, and the non-disturbed carrier frequency f_{16} is set to the address 13, as shown in Figure 11. Since the table is permanently prescribed, it is thus assured that the carrier frequency values are always present at their fixed addresses except when they are disturbed.

The values N = 96 and M = 75 are merely exemplary in the above description and can be replaced by other arbitrary values in other standards. The plurality of carrier frequency values in each sub-group and the plurality of randomly read-out carrier frequency values in each sub-group can also be adapted to the requirements of the respective standard.

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